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For: ROTARY FACE SEAL ASSEMBLY

1 1. A rotary seal assembly comprising:

2 a first member having a sealing face; and

3 a second member having a sealing face with a number of pumping

4 grooves therein, at least a first set of pumping grooves starting proximate a center portion

5 of the sealing face and extending outward and at least a second set of pumping grooves

6 starting proximate the center portion of the sealing face and extending inward to direct

7 fluid fed to the center portion of the sealing face simultaneously both inwardly and

8 outwardly from the center portion of the sealing face to provide a uniform fluid film

9 thickness between the sealing faces of the first and second members when one sealing

10 face cones due to thermal and/or pressure effects.

1 2. The rotary seal assembly of claim 1 further including a feeding groove for

2 providing fluid to the center portion of the sealing face.

1 3. The rotary seal assembly of claim 2 in which the feeding groove is in the

2 first member.

1 4. The rotary seal assembly of claim 2 in which the feeding groove is in the

2 second member and positioned at the center portion of the sealing face thereof.

1 5. The rotary face seal assembly of claim 2 in which the feeding groove is

2 discontinuous forming a number of feeding groove sections.

1 6. The rotary face seal assembly of claim 5 in which each feeding groove
2 section has an orifice therein.

1 7. The rotary face seal assembly of claim 6 in which the orifices are angled.

1 8. The rotary face seal assembly of claim 2 in which the feeding groove is
2 continuous.

1 9. The rotary face seal assembly of claim 8 further including a number of
2 orifices in the continuous feeding groove.

1 10. The rotary face seal assembly of claim 9 in which the orifices are angled.

1 11. The rotary face seal assembly of claim 1 in which the first member is a
2 stator ring.

1 12. The rotary face seal assembly of claim 11 in which the second member is a
2 rotor ring.

1 13. The rotary face seal assembly of claim 1 in which the first member is a
2 rotor ring.

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1 14. The rotary face seal assembly of claim 13 in which the second member is a
2 stator ring.

1 15. The rotary face seal assembly of claim 1 in which the first set of pumping
2 grooves each have a terminal end located inward of an outer portion of the sealing face.

1 16. The rotary face seal assembly of claim 1 in which the second set of
2 pumping grooves each have a terminal end located inward of an inner portion of the
3 sealing face.

1 17. The rotary face seal assembly of claim 1 in which the first set of pumping
2 grooves and the second set of pumping grooves start adjacent each other at the center
3 portion of the sealing face.

1 18. The rotary face seal assembly of claim 1 in which the starting position of
2 the first set of pumping grooves are offset from the starting position of the second set of
3 pumping grooves.

1 19. The rotary face seal assembly of claim 1 in which the first set of pumping
2 grooves curve outwardly from the center portion of the sealing face.

1 20. The rotary face seal assembly of claim 1 in which the second set of
2 pumping grooves curve inwardly from the center portion of the sealing face.

1 21. The rotary face seal assembly of claim 1 in which all the pumping grooves
2 have a width greatly exceeding their depth.

1 22. The rotary face seal assembly of claim 1 in which each pumping groove
2 has an inside edge and an outside edge, both edges curving inwardly.

1 23. The rotary face seal assembly of claim 1 in which each set of pumping
2 grooves includes the same number of pumping grooves.

1 24. The rotary face seal assembly of claim 2 in which the feeding groove has a
2 rounded bottom.

1 25. The rotary face seal assembly of claim 2 in which the feeding groove has a
2 square bottom.

1 26. The rotary face seal assembly of claim 1 further including a holder
2 mounted to one said member and movable therewith, and a spring which biases the first
3 and second members apart.

1 27. The rotary face seal assembly of claim 26 in which there is a gap between
2 the holder and the said member responsive to system pressure which overcomes the
3 spring at a predetermined level.

1 28. The rotary face seal assembly of claim 26 in which the holder includes a
2 shaft fixed thereto, the spring disposed about the shaft and abutting a non-movable
3 member.

1 29. The rotary face seal assembly of claim 1 further including a holder for one
2 said member configured to allow said member to cone negatively when the other member
3 cones positively and allows said member to cone positively when the other member cones
4 negatively.

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- 1 34. The rotary face seal assembly of claim 30 in which the orifices are
2 positioned in a continuous feeding groove formed in the first member.
- 1 35. The rotary face seal assembly of claim 34 in which the orifices are spaced
2 in the continuous feeding groove and extend through the thickness of the first member in
3 the continuous feeding groove.
- 1 36. The rotary face seal assembly of claim 35 in which the orifices are angled.
- 1 37. The rotary face seal assembly of claim 30 in which the first member is a
2 stator ring.
- 1 38. The rotary face seal assembly of claim 30 in which the second member is a
2 rotor ring.
- 1 39. The rotary face seal assembly of claim 30 in which the first member is a
2 rotor ring.
- 1 40. The rotary face seal assembly of claim 39 in which the second member is a
2 stator ring.
- 1 41. The rotary face seal assembly of claim 30 in which the first set of pumping
2 grooves each have a terminal end located inward of an outer portion of the sealing face of

3 the second member.

1 42. The rotary face seal assembly of claim 30 in which the second set of
2 pumping grooves each have a terminal end located inward of an inner portion of the
3 sealing face of the second member.

1 43. The rotary face seal assembly of claim 30 in which the first set of pumping
2 grooves and the second set of pumping grooves start adjacent each other at the center
3 portion of the sealing face of the second member.

1 44. The rotary face seal assembly of claim 30 in which the starting position of
2 the first set of pumping grooves are offset from the starting position of the second set of
3 pumping grooves.

1 45. The rotary face seal assembly of claim 30 in which the first set of pumping
2 grooves curve outwardly from the center portion of the sealing face of the second
3 member.

1 46. The rotary face seal assembly of claim 30 in which the second set of
2 pumping grooves curve inwardly from the center portion of the sealing face.

1 47. The rotary face seal assembly of claim 30 in which all the pumping
2 grooves have a width greatly exceeding their depth.

1 48. The rotary face seal assembly of claim 30 in which each pumping groove
2 has an inside edge and an outside edge, both edges curving inwardly.

1 49. The rotary face seal assembly of claim 30 in which each set of pumping
2 grooves includes the same number of pumping grooves.

1 50. The rotary face seal assembly of claim 31 in which the feeding groove
2 sections of the first member have rounded bottoms.

1 51. The rotary face seal assembly of claim 31 in which the feeding groove
2 sections of the first member have square bottoms.

1 52. The rotary face seal assembly of claim 30 further including a holder
2 mounted to whichever member is the stator and movable therewith, and a spring which
3 biases the first and second members apart.

1 53. The rotary face seal assembly of claim 52 in which there is a gap between
2 the holder and the stator member responsive to system pressure which overcomes the
3 spring at a predetermined level.

1 54. The rotary face seal assembly of claim 52 in which the holder includes a
2 shaft fixed thereto, the spring disposed about the shaft and abutting a non-movable
3 member.

1 55. The rotary face seal assembly of claim 30 further including a holder for
2 one said member configured to allow that member to cone negatively when the other
3 member cones positively and allows that member to cone positively when the other
4 member cones negatively.

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1 67. The rotary face seal assembly of claim 56 in which the rotor sealing face
2 has the orifices.

1 68. The rotary face seal assembly of claim 56 in which the stator sealing face
2 has the orifices.

1 69. The rotary face seal assembly of claim 56 in which the outwardly directed
2 pumping grooves each have a terminal end located inward of an outer portion of the
3 sealing face.

1 70. The rotary face seal assembly of claim 56 in which the inwardly directed
2 pumping grooves each have a terminal end located inward of an inner portion of the
3 sealing face

1 71. The rotary face seal assembly of claim 56 in which all the pumping
2 grooves start adjacent each other at the center portion of the sealing face.

1 72. The rotary face seal assembly of claim 56 in which the starting portition of
2 the pumping grooves are offset.

1 73. The rotary face seal assembly of claim 56 in which all the pumping
2 grooves have a width greatly exceeding their depth.

1 74. The rotary face seal assembly of claim 56 in which each pumping groove
2 has an inside edge and an outside edge, both edges curving inwardly.

1 75. The rotary face seal assembly of claim 56 in which each section includes
2 the same number of pumping grooves.

1 76. The rotary face seal assembly of claim 56 further including a spring which
2 biases the stator and the rotor apart.

1 77. The rotary face seal assembly of claim 76 in which there is a gap between
2 the holder and the stator member responsive to system pressure which overcomes the
3 spring at a predetermined level.

1 78. The rotary face seal assembly of claim 76 in which the holder includes a
2 shaft fixed thereto, the spring disposed about the shaft and abutting a non-movable
3 member.